

月 日 午 時 分

## 8256-28476

公開 昭和56年(1981)3月20日

民明25

運送法又 不送法

合 10 版:

明 老 和久平平六郎

東京都在田谷区田一丁目10番11

ॐ नमो भगवते वासुदेवाय

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果尔则任至本区第一号后10名。

号在王城山内，故在王城山内。

我如 而 人 既得正氣必可全；

2010年10月10日 星期六

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1. 号数と戸数同様に合計四

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[illegible]

(7) 電報、電話、郵便、新聞、雑誌、書籍、映画、音楽、演劇、スポーツ、娯楽、その他、

四、 蘇聯政府及蘇聯人民對於德意志民主共和國  
 之成立表示極大之同情及支持，並願與德意志民主共和國  
 合作，以實現德意志之統一，並願與德意志民主共和國  
 人民共同為實現德意志之統一而奮鬥。

1947年10月1日  
 1. 10月1日，国民党政府迁往台湾，宣告结束在大陆的统治。  
 2. 10月1日，中华人民共和国宣告成立，开始新的历史篇章。  
 3. 10月1日，是中国人民站起来的日子，也是中华民族重新屹立于世界民族之林的日子。  
 4. 10月1日，是中国共产党领导中国人民取得革命胜利的日子，也是中国人民从此当家作主的日子。  
 5. 10月1日，是中国人民开始建设社会主义国家的日子，也是中国人民开始实现国家富强的日子。  
 6. 10月1日，是中国人民开始实现民族复兴的日子，也是中国人民开始实现中国梦的日子。  
 7. 10月1日，是中国人民开始实现国家统一的日子，也是中国人民开始实现国家繁荣的日子。  
 8. 10月1日，是中国人民开始实现社会和谐的日子，也是中国人民开始实现国家稳定的日子。  
 9. 10月1日，是中国人民开始实现国家民主的日子，也是中国人民开始实现国家进步的日子。  
 10. 10月1日，是中国人民开始实现国家文明的日子，也是中国人民开始实现国家现代化的日子。

(U) [REDACTED]  
[REDACTED]  
[REDACTED]  
[REDACTED]  
[REDACTED]

10. 研究經費來源及分配情形

足つた電報機とその他の電機器具で電報電氣事業の  
用電電壓は200ボルトと電報電氣事業と通信電報の  
ための電力を、その電氣設備するところの  
その電報機とその他の電機器具の間の電氣  
の電氣設備の電氣の電氣設備。

[illegible][illegible]

例、由圖中可知，在△ABC中， $\angle A = 90^\circ$ ， $\angle B = 30^\circ$ ， $\angle C = 60^\circ$ ， $\angle A$ 對邊BC， $\angle B$ 對邊AC， $\angle C$ 對邊AB。  
 由圖中可知，在△ABC中， $\angle A = 90^\circ$ ， $\angle B = 30^\circ$ ， $\angle C = 60^\circ$ ， $\angle A$ 對邊BC， $\angle B$ 對邊AC， $\angle C$ 對邊AB。  
 由圖中可知，在△ABC中， $\angle A = 90^\circ$ ， $\angle B = 30^\circ$ ， $\angle C = 60^\circ$ ， $\angle A$ 對邊BC， $\angle B$ 對邊AC， $\angle C$ 對邊AB。

1. 關於本會之組織及職權範圍，業經本會第一次會員大會通過，並經內政部核准在案。

此の事は、元來、日本に於ける、政治、経済、社会、文化、の各面に於ける、  
 最も重要な問題である。其の解決は、日本の将来を決定するものである。  
 故に、我々は、此の問題を、最も重要な問題として、取り扱うべきである。  
 其の解決は、日本の将来を決定するものである。

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昭和十一年一月一日を以て、本會で定めた  
 本會の組織及び、その業務の執行等、並び  
 に、その財政の管理、その他、本會の事務  
 及び、その執行等、を規定する。

國 内の労働環境は戦後の労働法改正等によって整  
 備され、労働者の権利と労務管理の両方から、  
 一層充実のするところとなり、労働者の生活も  
 向上しているが、労働者の健康と安全の確保が  
 必要である。

[illegible]

解 同題步成後，將各列的數值，由左至右，  
 由上而下，逐列相加，所得結果，即為各  
 項的總和。如左圖所示，則各項的總和為  
 100。此種方法，在計算上，極為簡便，且  
 可避免重複計算之弊。此種方法，在計算  
 上，極為簡便，且可避免重複計算之弊。

[illegible]

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[illegible][illegible][illegible][illegible][illegible]

四 同様に、自然現象の理解を促して進歩して知識を大衆に普及せしむるが目的は、教育行政に在り、その方針として、  
「一、基礎知識を、二、専門知識を、三、応用知識を、四、進歩知識を、五、  
六、進歩知識を、七、進歩知識を、八、進歩知識を、九、進歩知識を、  
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九十八、進歩知識を、九十九、進歩知識を、一百、進歩知識を、

[illegible]

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第一、政治經濟的變遷と社會意識の變遷との關係の問題  
 である。社會意識の變遷は、政治經濟の變遷に及び、政治  
 經濟の變遷は、社會意識の變遷に及ぶ。政治經濟の變遷は、  
 社會意識の變遷を決定する。社會意識の變遷は、政治經濟  
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 決定する。社會意識の變遷は、政治經濟の變遷を決定する。

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[illegible][illegible]

以下圖示我國與日本之貿易關係及日本之貿易關係

[illegible]

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先填问题

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神志同春



1. 本件は、原告が被告に対して、  
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THE FOLLOWING IS A SUMMARY OF THE INFORMATION RECEIVED FROM THE SOURCE DURING THE PERIOD OF THE INVESTIGATION. THE SOURCE HAS ADVISED THAT THE INDIVIDUALS NAMED IN THE ATTACHED LIST ARE CURRENTLY ACTIVE IN THE AREA OF THE INVESTIGATION. THE SOURCE HAS ALSO ADVISED THAT THE INDIVIDUALS NAMED IN THE ATTACHED LIST ARE CURRENTLY ACTIVE IN THE AREA OF THE INVESTIGATION. THE SOURCE HAS ALSO ADVISED THAT THE INDIVIDUALS NAMED IN THE ATTACHED LIST ARE CURRENTLY ACTIVE IN THE AREA OF THE INVESTIGATION.

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二、在“三反”斗争中，要正确地对待犯错误的干部。对于犯错误的干部，不能一棍子打死，而要具体分析，区别对待。对于那些犯了一般性错误，但本质好的干部，应当给予教育和帮助，使他们改正错误，继续工作。对于那些犯有严重错误，但仍有悔改可能的干部，也要给以改过自新的机会。只有对那些严重违法乱纪、屡教不改的干部，才应予以撤职或开除处分。

410136 88061612, 70-0000

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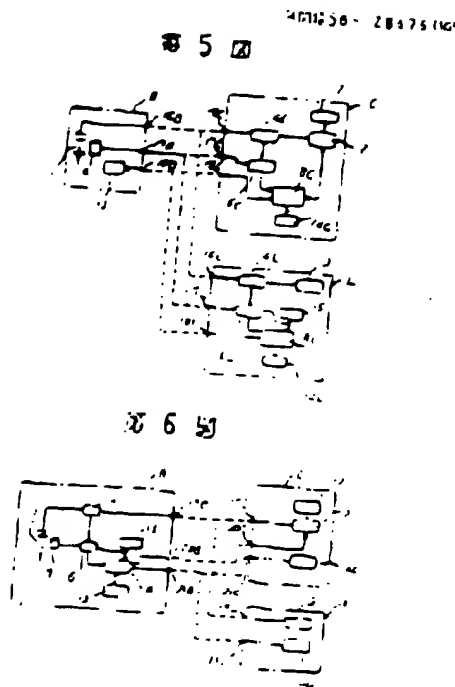
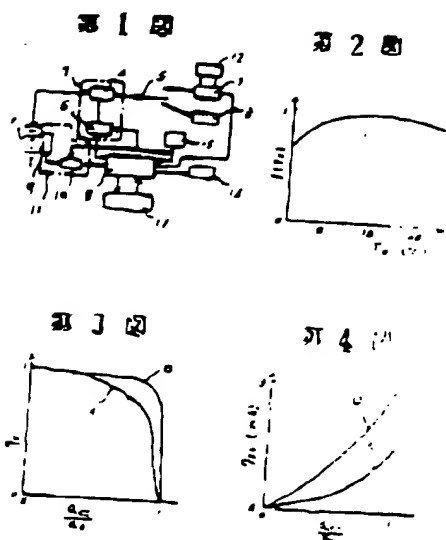
[illegible][illegible]

( 83 )

[illegible][illegible]

八、九、十、十一、十二、十三、十四、十五、十六、十七、十八、十九、二十、二十一、二十二、二十三、二十四、二十五、二十六、二十七、二十八、二十九、三十、三十一、三十二、三十三、三十四、三十五、三十六、三十七、三十八、三十九、四十、四十一、四十二、四十三、四十四、四十五、四十六、四十七、四十八、四十九、五十、五十一、五十二、五十三、五十四、五十五、五十六、五十七、五十八、五十九、六十、六十一、六十二、六十三、六十四、六十五、六十六、六十七、六十八、六十九、七十、七十一、七十二、七十三、七十四、七十五、七十六、七十七、七十八、七十九、八十、八十一、八十二、八十三、八十四、八十五、八十六、八十七、八十八、八十九、九十、九十一、九十二、九十三、九十四、九十五、九十六、九十七、九十八、九十九、一百。

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## 第 1 頁の続き

①発明者 大西和則

東京都世田谷区結一下月10番11  
号日本放送協会総合技術研究所  
内

②発明者 川村剛

国分寺市東通一丁目2番5号  
地産株式会社日立製作所中央研  
究所内

③発明者 野口浩

小平市御幸町32番地日立電子有  
限会社小倉井工場内

④発明者 坪ア谷文雄

小平市御幸町32番地日立電子有  
限会社小倉井工場内

⑤出願人 日本放送協会

東京都世田谷区神田二丁目2番1  
号

⑥出願人 株式会社日立製作所

東京都千代田区丸の内一丁目6  
番1号

⑦代理人 日立電子株式会社

東京都千代田区神田須田町1-7  
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(11) Japanese Patent Application Kokai Publication No.  
(12) Publication of Unexamined Patent Application (A) Sho56-28476

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G 01 R 31/36		7359-2G

(43) Date of Publication of Unexamined Patent Application 1981 March 20  
Number of Inventions 4  
Request for Examination Not Submitted

(Total of 10 Pages in the Original Japanese)

(54) Storage battery residual capacity meter

(21) Patent application Filing No. Sho54-103382

(22) Application Filing Date 1979 August 14

(72) Inventor Kikuoka Takao  
Within the Shin-Kobe Electric Machinery Co., Ltd. 2-1-1 Nishi-Shinjuku,  
Shinjuku-ku, Tokyo

(72) Inventor Yamamoto Hiroaki  
Within the Shin-Kobe Electric Machinery Co., Ltd. 2-1-1 Nishi-Shinjuku,  
Shinjuku-ku, Tokyo

(72) Inventor Sasaki Noriyoshi  
Within the Shin-Kobe Electric Machinery Co., Ltd. 2-1-1 Nishi-Shinjuku,  
Shinjuku-ku, Tokyo

(72) Inventor Wakui Kotaro  
Within the Japan Broadcasting Corporation Comprehensive Technology  
Laboratory 1-10-11  
Kinuta, Setagaya-ku, Tokyo

(72) Inventor Murakami Yoshinosuke  
Within the Japan Broadcasting Corporation Comprehensive Technology  
Laboratory 1-10-11  
Kinuta, Setagaya-ku, Tokyo

(71) Applicant Shin-Kobe Electric Machinery Co., Ltd. 2-1-1 Nishi-Shinjuku,  
Shinjuku-ku, Tokyo

Continued on last page  
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### Specification

1. Title of the Invention:

Meter for Remaining Capacity in Storage Battery

2. Claims:

- (1) A meter for remaining capacity in a storage battery comprising:

a quantity of electricity detecting portion for detecting a charged quantity of electricity and a discharged quantity of electricity in said storage battery so as to output the charged quantity of electricity and the discharged quantity of electricity as digital signals;

a temperature detecting portion for detecting the temperature of said storage battery so as to output the detected temperature as a digital signal;

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a memory means that stores data and an equation required for calculating at least one of the quantities of either dischargeable electricity or time dischargeable by using the detected quantity of both the charged and discharged electricity and the detected temperature;

a digital calculation processing portion which calculates through digital calculation at least one of the quantity of dischargeable electricity and the time dischargeable by using a signal output from said quantity of electricity detecting portion and said temperature detecting portion, data stored in said memory means, and the equation; and

a display portion for displaying at least one of the dischargeable quantity of electricity and the dischargeable time.

- (2) A meter for remaining capacity in a storage battery according to claim 1 wherein said temperature detecting portion comprises a temperature detector disposed in the vicinity of

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said storage battery and an analog/digital converter for converting an output from the temperature detector into a digital quantity.

- (3) A meter for remaining capacity in a storage battery according to claim 2 wherein said quantity of electricity detecting portion comprises a quantity of electricity detector for detecting the charged quantity of electricity and the discharged quantity of electricity by generally calculating both a charged current and a discharged current, and an analog/digital converter for converting an output from the quantity of electricity detector into a digital quantity.
- (4) A meter for remaining capacity in a storage battery according to claim 3 wherein said temperature detector and said quantity of electricity detector operate at all times, and each of said analog/digital converters, said digital operation processing portion, and said memory portion operate intermittently.

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- (5) A meter for remaining capacity in a storage battery according to claim 2 wherein said quantity of electricity detecting portion comprises an amperage detector for detecting a charged amperage and a discharged amperage, an analog/digital converter for converting an output from the analog/digital converter into a digital quantity and a calculation means for time integrating the output from the analog/digital converter.
- (6) A meter for remaining capacity in a storage battery according to claim 5 wherein said temperature detector and said current detector operate at all times, each of said analog/digital converters, said calculation means, said digital calculation processing portion, and said memory means operate intermittently.
- (7) A meter for remaining capacity in a storage battery according to claim 6 wherein said digital calculation processing portion also serves as said calculation means.

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(8) A meter for remaining capacity in a storage battery comprising:

a quantity of electricity detecting portion for detecting a charged quantity of electricity and a discharged quantity of electricity in said storage battery so as to output the charged quantity of electricity and the discharged quantity of electricity as digital signals;

a temperature detecting portion for detecting the temperature of said storage battery so as to output the detected temperature as a digital signal;

a storage battery capacity measuring portion for measuring the capacity of said storage battery by connecting a dummy load to said storage battery to discharge said storage battery;

a memory means that stores each kind of data, including a discharge capacity, at a standard temperature and an equation required for calculating at least one of either the quantity of

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dischargeable electricity or time dischargeable at a detected temperature by using the detected quantity of both the charged and discharged electricity and the detected temperature.

a digital calculation processing portion for calculating out through digital calculation at least one of the quantity of dischargeable electricity and the dischargeable time by using a signal output from said quantity of electricity detecting portion and said temperature detecting portion, data stored in said memory means, and the equation; and

a display portion for displaying at least one of the dischargeable quantities of electricity and the time dischargeable;

wherein said digital operation processing portion calculates out the discharge capacity at the standard temperature by using the capacity of said storage battery detected in the measurement of the capacity by the storage battery capacity measuring portion, the signal output from said temperature

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detector and the data stored in the circuit of said memory means so that the discharge capacity at the standard temperature is stored in said memory circuit as new data to compensate for any variation in the capacity resulting from the aging of said storage battery.

- (9) A meter for remaining capacity in a storage battery according to claim 8 wherein said temperature detecting portion comprises a temperature detector disposed in the vicinity of said storage battery and an analog/digital converter for converting an output from the temperature detector into a digital quantity.
- (10) A meter for remaining capacity in a storage battery according to claim 9 wherein said quantity of electricity detecting portion comprises a quantity of electricity detector for detecting the charged quantity of electricity and the discharged quantity of electricity by generally calculating both the charged current and the discharged current, and an analog/digital converter for converting an output from the

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quantity of electricity detector into a digital quantity.

- (11) A meter for remaining capacity in a storage battery according to claim 10 wherein said temperature detector and said quantity of electricity detector operate at all times, and each of said analog/digital converters, said digital calculation processing portion, and said memory portion operate intermittently.
- (12) A meter for remaining capacity in a storage battery according to claim 11 wherein said quantity of electricity detecting portion comprises an amperage detector for detecting a charged amperage and a discharged amperage, an analog/digital converter for converting an output from the analog/digital converter into a digital quantity, and a calculation means for time integrating the output from the analog/digital converter.
- (13) A meter for remaining capacity in a storage battery according to claim 12 wherein said

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temperature detector and said current detector operate at all times, each of said analog/digital converters, said calculation means, said digital operation processing portion, and said memory means operate intermittently.

- (14) A meter for remaining capacity in a storage battery according to claim 13 wherein said digital calculation processing portion also serves as said calculation means.

- (15) A meter for remaining capacity in a storage battery comprising:

a quantity of electricity detecting portion for detecting a charged quantity of electricity and a discharged quantity of electricity in said storage battery so as to output the charged quantity of electricity and the discharged quantity of electricity as digital signals;

a temperature detecting portion for detecting the temperature of said storage battery so as to

output the detected temperature as a digital signal;

a portion for detecting the time which said storage battery is allowed to stand idle which totals such time and converts the total time into a digital signal;

a memory means that stores data and equations required for calculating at least one of the quantities of dischargeable electricity and time dischargeable by using the detected quantity of both the charged and discharged electricity and the detected temperature, as well as data, and the equations required for compensating for said dischargeable quantity of electricity and said time dischargeable by calculating the quantity of electricity self-discharged within said time during which said storage battery is allowed to stand idle;

a digital calculation processing portion for calculating out through digital calculation at least one of the quantities of dischargeable

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electricity and the time dischargeable by using a signal output from said quantity of electricity detecting portion and said temperature detecting portion, data, and the equation stored in said memory means so as to compensate for variation in the discharge capacity resulting from said self discharge; and

a display means for displaying at least one of either said dischargeable quantity of electricity or said time dischargeable.

- (16) A meter for remaining capacity in a storage battery according to claim 15 wherein said temperature detecting portion comprises a temperature detector disposed in the vicinity of said storage battery and an analog/digital converter for converting an output from the temperature detector into a digital quantity.
- (17) A meter for remaining capacity in a storage battery according to claim 16 wherein said quantity of electricity detecting portion comprises a quantity of electricity detector for

detecting the charged quantity of electricity and the discharged quantity of electricity by generally calculating both a charged current and a discharged current, and an analog/digital converter for converting an output from the quantity of electricity detector into a digital quantity.

(18) A meter for remaining capacity in a storage battery according to claim 17 wherein said temperature detector and said quantity of electricity detector operate at all times, and each of said analog/digital converters, said digital calculation processing portion, and said memory portion operate intermittently.

(19) A meter for remaining capacity in a storage battery according to claim 18 wherein said quantity of electricity detecting portion comprises a current detector for detecting a charged current and a discharged current, an analog/digital converter for converting an output from the analog/digital converter into a digital quantity, and a calculation means for time

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integrating the output from the analog/digital converter.

- (20) A meter for remaining capacity in a storage battery according to claim 18 wherein said temperature detector, said current detector, and a portion for detecting the time during which said storage battery is allowed to stand idle operate at all times, and each of said analog/digital converters, said calculation means, said digital calculation processing portion, and said memory means operate intermittently.
- (21) A meter for remaining capacity in a storage battery according to claim 19 or claim 20 wherein said digital calculation processing portion also serves as said calculation means.
- (22) A meter for remaining capacity in a storage battery comprising:
- a quantity of electricity detecting portion for detecting a charged quantity of electricity and a



discharged quantity of electricity in said storage battery so as to output the charged quantity of electricity and the discharged quantity of electricity as digital signals;

a temperature detecting portion for detecting the temperature of said storage battery so as to output the detected temperature as a digital signal;

a storage battery capacity measuring portion for measuring the capacity of said storage battery by connecting a dummy load to said storage battery so as to discharge said storage battery;

a portion for detecting the time which said storage battery is allowed to stand idle which totals such time and converts the total time into a digital signal;

a memory means that stores data and equations required for calculating at least one of the quantities of dischargeable electricity and time dischargeable by using the detected quantity of

both the charged and discharged electricity and the detected temperature, as well as data, and the equations required for compensating for said dischargeable quantity of electricity and said time dischargeable by calculating the quantity of electricity self-discharged within said time during which said storage battery is allowed to stand idle;

a digital calculation processing portion for calculating out through digital calculation at least one of the quantities of either dischargeable electricity and the time dischargeable by using a signal output from said quantity of electricity detecting portion and said temperature detecting portion, data, and the equation stored in said memory means so as to compensate for variation in the discharge capacity resulting from said self-discharge; and

a display means for displaying at least one of either said dischargeable quantity of electricity or said time dischargeable;

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wherein said digital calculation processing portion calculates a discharge capacity at said standard temperature by using the capacity of said storage battery detected in the measurement of the capacity by the storage battery capacity measuring portion, the temperature detected by said temperature detector, and the data stored in the circuit of said memory means so that the discharge capacity at the standard temperature is stored in said memory circuit as new data so as to compensate for variation in the capacity resulting from the aging of said storage battery.

- (23) A meter for remaining capacity in a storage battery according to claim 22 wherein said temperature detecting portion comprises a temperature detector disposed in the vicinity of said storage battery and an analog/digital converter for converting an output from the temperature detector into a digital quantity.
- (24) A meter for remaining capacity in a storage battery according to claim 23 wherein said quantity of electricity detecting portion

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comprises a quantity of electricity detector for detecting the charged quantity of electricity and the discharged quantity of electricity by generally calculating both a charged current and a discharged current, and an analog/digital converter for converting an output from the quantity of electricity detector into a digital quantity.

- (25) A meter for remaining capacity in a storage battery according to claim 24 wherein said temperature detector and said quantity of electricity detector operate at all times, and each of said analog/digital converters, said digital calculation processing portion, and said memory portion operate intermittently.
- (26) A meter for remaining capacity in a storage battery according to claim 25 wherein said quantity of electricity detecting portion comprises a current detector for detecting a charged current and a discharged current, an analog/digital converter for converting an output from the analog/digital converter into a digital

quantity, and a calculation means for time integrating the output from the analog/digital converter.

- (27) A meter for remaining capacity in a storage battery according to claim 26 wherein said temperature detector, said current detector, and a portion for detecting the time which said storage battery is allowed to stand idle operate at all times, and each of said analog/digital converters, said calculation means, said digital calculation processing portion, and said memory means operate intermittently.
- (28) A meter for remaining capacity in a storage battery according to claim 26 or claim 27 wherein said digital calculation processing portion also serves as said calculation means.

3. Detailed Description of the Invention:

The present invention relates to a meter for remaining capacity in a storage battery that displays the

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remaining capacity and charge condition of the storage battery.

Storage batteries such as nickel cadmium storage batteries and lead batteries have quite recently come to be widely used as a power source for portable electric appliances. In any type of storage battery, the quantity of electricity that can be supplied through one charging is limited. When a load is driven by such batteries for a certain period of time, the battery requires charging. To improve the availability factor of an electric appliance, it is necessary to know how much electricity can be supplied to the storage batteries being discharged. One device that meets this purpose is the remaining capacity meter. The conventional type of meter for remaining capacity directly measures the quantity of charged and discharged electricity and displays the remaining capacity. In general, the remaining capacity is greatly affected by the temperature of the batteries and the charging efficiency. As a result, the accurate detection of remaining capacity is not possible by the simple measurement of the quantity of charged and discharged electricity, and it is necessary to

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compensate for the affect of the temperature and the charging efficiency. However, because conventional remaining capacity meters perform this kind of compensation calculation by analog means their precision cannot be raised, and the remaining capacity cannot be accurately indicated. In addition, in order to determine the remaining capacity accurately it is necessary to compensate for the variation in the life of batteries and the variation in capacity resulting from self-discharge when they are allowed to stand idle. It was extremely difficult for analog remaining capacity meters to perform such compensation calculation.

The object of the present invention is to provide a remaining capacity meter in a storage battery which can accurately perform compensation calculation owing to the temperature of the battery, the charging efficiency, variation in the life the battery, and the self-discharge thereof and display the remaining capacity with high precision.

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A meter for remaining capacity in accordance with the present invention will be detailed hereunder with reference to the embodiment shown in the drawings.

Figure 1 schematically shows an embodiment in which remaining capacity in a nickel cadmium storage battery is displayed. Referring to Figure 1, Reference Number 1 designates a nickel cadmium storage battery, 2 a charger for charging the storage battery, 3 a load (for example, a portable VTR and a TV camera) driven by the storage battery 1, 4 a quantity of electricity detector for showing a quantity of electricity by integrating charged and discharged current in the storage battery 1. In the embodiment shown in Figure 1, the charger 2 and the load 3 are connected to the storage battery via a shift-over switch 5 and the quantity of electricity detector 4. When the battery is charged, the charger 2 is connected to the battery 1 via the quantity of electricity detector 4. When the battery is loaded the load 3 is connected to the battery 1 via the electricity quantity detector 4.

The quantity of electricity detector 4 can comprise, for example, small resistors inserted in series into a



circuit through which charged and discharged current in the battery passes along with a potential memory device connected in parallel to the small resistors. The potential memory device outputs a voltage proportional to the quantity of electricity that passes through it. For example, a device known by the trade name "memoryode" manufactured by Sanyo Electric Co., Ltd., can be used as the potential memory device. As the above quantity of electricity device 4, a coulomb meter or the like can be used. An analog signal proportional to the quantity of charged and discharged electricity obtained by the quantity of electricity detector 4 is entered into an analog/digital converter 6 in which the analog signal is converted into a digital signal. The quantity of electricity detector 4 and the analog/digital converter 6 detect the quantity of charged electricity and the quantity of discharged electricity. Thus the quantity of electricity detector 4 and the analog/digital converter 6 constitutes a quantity of electricity detecting portion 7 that detects the quantity of charged electricity and the quantity of discharged electricity and outputs these quantities as digital signals. The digital signal given by the

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converter 6 enters into a digital calculation processing portion 8.

To detect the temperature of the storage battery 1, a temperature detector 9 is disposed in the vicinity of the storage battery 1. The temperature detector used in the storage battery comprises, for example, a temperature detecting device that outputs a current proportional to the absolute temperature, the temperature detecting device having a resistance and a direct current power source connected in series to it, thereby making it possible to give across this resistance a voltage for temperature detection proportional to the absolute temperature. Such a temperature detecting device includes an AD 590 manufactured by Analog Devices, Inc. A temperature detecting signal given by the temperature detector 9 enters into an analog/digital converter 10 wherein the signal is converted into a digital signal. In this particular embodiment, the temperature detector 9 and the analog/digital converter 10 constitutes temperature detecting portion 11 which detects the temperature of the battery and converts the detected temperature into a digital signal. The digital signal given by the

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converter 10 enters into the digital calculation processing portion 8.

Data designating the number of chargings enters from the charger 2 into the digital calculation processing portion 8. This data is used for determining the time when the variation in the life of the discharge capacity of the battery 1 is to be measured. To measure the variation in the life of the battery and heighten the precision in the calculation of the remaining capacity, a dummy load 12 is provided on the side of the charger 2. This dummy load 12 permits actual measurement of the discharge capacity of the storage battery. The dummy load 12 is connected to the storage battery each time a predetermined number of charging operations is performed. Consequently, the battery is discharged to the termination voltage via the dummy load 12 to allow the portion 7 for detecting the quantity of charged and discharged electricity to actually measure the discharge capacity. This data enters into the digital calculation processing portion 8.

A memory circuit 13 is mounted to store data and an equation required for calculations performed by the digital calculation processing portion 8. A display portion 14 is connected to the output end of the digital calculation processing portion 8. Only necessary results out of the results of the calculations performed by the digital calculation processing portion 8 are displayed on the display portion 14.

In the remaining capacity meter shown in Figure 1, the analog/digital converters 6 and 10, the digital operation processing portion 8, and the memory circuit 13 are driven by the storage battery 1. It is necessary to minimize the power consumed in the circuit of the remaining capacity meter and to relieve the load applied to the storage battery in order to supply sufficient power to the load 3. For this purpose, a timer 15 is mounted in the embodiment shown in Figure 1. Analog/digital converters 6 and 10, the digital calculation processing portion 8, and the memory circuit 13 are actuated with a signal transmitted from the timer at a certain interval, for example, once in every five minutes, so that these devices perform their

own predetermined calculation. After the predetermined calculations, power supply to each device is automatically cut off. On the other hand, when the battery 1 is allowed to stand idle without being connected to the load 3 or the charger 2, the timer 15 terminates the movement of the analog/digital converter 6 and the operation of the digital calculation processing portion 8. When the battery 1 is connected to the load 3 or the charger 2, the time which the battery is allowed to stand idle is integrated and entered into the calculation processing portion 8. In addition, when the battery 1 is allowed to stand idle, an instruction is given at a certain time interval to the temperature detector 11 in order to detect the temperature of the storage battery 1. The temperature thus detected is stored in the memory circuit 13. The time which the battery is allowed to stand idle and the temperature thereof during the time stored in the memory circuit 13 are used as data for compensating for the variation in the capacity owing to self-discharge. When the battery is connected to the load 3 or the charger 2, the digital calculation processing portion 8 performs an operation for compensating for the variation in the discharge capacity owing to the

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self-discharge to calculate the remaining capacity or the like.

The digital calculation processing portion 8 calculates at least one of either the dischargeable quantity of electricity (remaining capacity) or time dischargeable. In addition, this portion also performs operations for calculating the charging state, the variation in the life of the battery at standard temperature, and compensating for the variation in remaining capacity owing to self-discharge. Data and equations required for performing these operations are stored in the memory circuit 13. The data and equation stored therein depend on the kind of battery and the parameter selection method. For example, in the case of a nickel cadmium storage battery, the following data is stored:

- (I) The relationship between the battery temperature  $T_b(^{\circ}\text{C})$  and the ratio  $f(T)$  of the discharge capacity at the battery temperature during discharge against the discharge  $Q_s(\text{Ah})$  at the standard temperature (hereinafter referred to as the standard discharge capacity)

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- (II) The relationship between the charging efficiency of the battery and the ratio  $Q_c/Q_0$  of the battery temperature  $T_b$  and the charged state  $Q_c$  (Ah) against the standard discharge capacity  $Q_0$ .
- (III) The relationship between the self-discharge current  $\eta_{sd}$  (mA) and the ratio of the battery temperature  $T_b$  and the charged state against the standard discharge capacity  $Q_0$ .

The above data is to be determined in advance through testing or the like. An example of data (I), (II) and (III) is shown in Figure 2, Figure 3 and Figure 4 respectively.

Incidentally, referring to Figures 3 and 4, curves a and b designate cases where the battery temperature  $T_b$  stand idles at 0°C and 20°C, respectively.

As described above, in accordance with the present invention, the memory circuit stores all data used for the compensation. Even when the size of the battery or the load changes, the circuit itself need not be

modified unlike in the case of the conventional analog type. Only the data stored in the memory circuit 13 has to be modified.

The digital calculation processing portion 8 reads voltage values entered from the analog/digital converter 6. The quantity of discharged electricity  $Q_d$  that flows through the circuit during the reading time and the quantity of charged electricity  $Q_c$  are calculated from the difference between the voltage value read by the portion 8 and the value stored in the memory circuit 13 read by the same portion in the previous calculation and the proportional constant of the variation in the output voltage of the quantity of electricity detector 4 stored in advance in the memory circuit against the quantity of charged and discharged electricity. Then the following calculations are performed with the quantity of electricity  $Q_c$  and  $Q_d$  thus calculated, the temperature of the storage battery detected by the temperature detector 11, the charging time given by the charger 2, the measured time which the storage battery is allowed to stand idle, and the data stored in the memory circuit 13, the above time

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being measured by the timer 15. The result of the calculations is displayed on the display portion 14.

(1) Calculation of Remaining Capacity

When the battery 1 is discharged with a load connected to it, the remaining capacity of the battery is calculated and displayed. A possible method for displaying the remaining capacity includes one for directly displaying the quantity of dischargeable electricity  $Q_r$  retained in the storage battery 1 and one for displaying the time dischargeable (time during which the battery can be discharged) as a load current. In accordance with the present invention, the remaining capacity can be displayed as either of the quantity of dischargeable electricity or time dischargeable. Otherwise, the remaining capacity can be displayed as both the quantity of dischargeable capacity and the time dischargeable. The quantity of dischargeable capacity  $Q_r$  is calculated based on the quantity of discharged electricity  $Q_d$ , the temperature  $T$ , of the battery, and the data stored

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in the memory circuit 13 through the following equation:

$$Q_t = Q_s (f(T_s) - 1) + Q_{c,t} - \Sigma Q_{d,t} \quad \text{--- (1)}$$

wherein  $Q_s$  designates the standard discharge capacity,  $Q_{c,t}$  the charged state at the termination of the previous charging operation (the calculation of the charged state will be detailed hereinafter), and  $\Sigma Q_{d,t}$  the total quantity of discharge after the initiation of the present charge. In addition, an example of the function  $f(T_s)$  is shown in Figure 2. Incidentally, the time dischargeable can be obtained by dividing the above quantity of dischargeable electricity  $Q_d(Ah)$  by the discharged current. Either one or both of the quantity of dischargeable electricity and the dischargeable time is displayed on the display portion 14.

(2) Calculation of the Charged State  $Q_{cs}$ 

The charged state of electricity (the quantity of electricity charged in the storage battery) is calculated based on the quantity of charged electricity  $Q_c$ , the temperature  $T_b$  of the battery, the charging time  $t$ , required up to the number of times  $k$  for reading data, and the data stored in the memory circuit 13 in the following equation:

$$Q_{cs}(t_k) = Q_{cs}(t_{k-1}) - \eta_c(T_b, \frac{Q_{cs}(t_{k-1})}{Q_c}) \cdot Q_c \quad \text{--- (2)}$$

wherein  $Q_{cs}$  designates the charged state at  $k$  number of times of reading data. The time of the initiation of the charging is represented by the following equation:

$$Q_{cs}(t_0) = Q_c - \Sigma Q_c \quad \text{--- (3)}$$

Incidentally, an example of the function  $\eta_c(T_b, Q_{cs}(t_{k-1})/Q_c)$  is shown in Figure 3.

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The above charged state is calculated in every definite time determined by the timer 15. The result of the calculation is displayed on the display portion 14. Thus such a display of the charged state simultaneously provides the process of the charging when a plurality of storage batteries so as to make it possible to easily predict the time when the charging process is completed. This facilitates the usage schedule of the storage battery. Although, the calculation of the charged state is absolutely required, the display thereof is not necessarily needed.

Upon completion of the charging of the storage battery 1, the charged state  $Q_c$  at that time is compared with the standard discharge capacity  $Q_0$ . A smaller value is stored in the memory circuit 13 as  $Q_c$ .

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(3) Calculation for Compensating for Variation in the Capacity Owing to the Self-Discharge of the Storage Battery

The storage battery 1 self-discharges to some degree when no electricity is supplied to a load. Thus correct calculation of the remaining capacity requires the calculation of the loss of electricity owing to self-discharge so as to compensate for such loss. In the present invention, when a storage battery is allowed to stand idle, the charged state after the compensation of the loss of electricity owing to self-discharge is calculated at the initiation of the discharge based on the battery temperature  $T$ , the time  $t$ , which the battery is allowed to stand idle until the number of time  $t$  for reading data, and the data stored in the memory circuit 13 using the following equation:

$$Q_{ce}(C_i) = Q_{ce}(C_{i-1}) - \eta_{sv} \left( \frac{Q_{cs}(C_{i-1})}{Q_c} \right) \cdot (C_i - C_{i-1}) \quad \text{--- (4)}$$

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wherein  $Q_{ch}(t_i)$  designates the charged state in the case of data reading circuit  $i$ . An example of the function  $\eta_{dp}(T_i, Q_{ch}(t_i)/Q_0)$  is shown in Figure 4. The charged state at the initiation of the discharge is designated by

$$Q_{ch}(T_i) = Q_{ch} - \eta Q_0 \quad \text{--- (5)}$$

The quantity of dischargeable electricity is calculated with the charge  $Q_{ch}$  represented by  $Q_{ch}(T_i)$ .

(4) Calculation for Compensating for Variation in the Capacity Owing to the Change in the Life of the Storage Battery

In general, storage batteries gradually decrease in capacity along with increase in the number of the discharge cycles. Storage batteries are normally replaced by a new one when the capacity decreases to less than 50% in most cases. Thus the capacity of the storage battery changes during its life. Thus, when the standard discharge capacity  $Q_0$  is kept at a preset level, the

remaining capacity thus calculated generates a large error. The following method is available for approximating the standard discharge capacity with regard to the capacity of the storage battery at that point.

- (a) The standard discharge capacity is compensated for during calculation by determining and storing in advance in the memory circuit 13 the relationship between the deterioration in the life of the storage battery and the period of usage, the number of charging and discharging cycle, the integrated quantity of discharged electricity, and the integrated quantity of stored electricity.
- (b) After the storage battery is completely charged, the storage battery is actually discharged to measure the capacity of the storage battery. The measured value is compensated for in terms of temperature, and

the measured value is used as the standard discharge capacity  $Q_0$ .

In the present invention, any of these methods can be used. In the embodiment shown in Figure 1, compensation for life is carried out with the method (b). Consequently, in the embodiment shown in Figure 1, a dummy load 12 is provided on the side of the charger 2. After the storage battery is completely charged, the dummy load 12 is connected to the storage battery 1. The quantity of the discharged electricity is thus detected, and the capacity of the storage battery is actually measured. In this case, two methods can be considered as means for determining the capacity of the storage battery. In one method, the capacity of the storage battery is determined from the relationship between the capacity of the storage battery and the discharge voltage measured and determined in advance by allowing the storage battery 1 to momentarily discharge. In the other method, the capacity of the storage battery is actually measured by allowing the storage battery



to completely discharge to termination voltage. In the case of nickel cadmium storage batteries, the variation in the discharge voltage is small. It is also very difficult to measure the capacity of the storage battery. In this embodiment, the method of discharging the battery to the termination voltage is adopted. An actual measurement of the capacity of the storage battery is performed once when a predetermined number of charging operations (for example thirty times) is performed. After the discharge capacity is measured, the storage battery is recharged. The number of charging operations is counted with a counter incorporated into the charger 2. When the number of charging operations reaches a predetermined number, a signal is transmitted to a digital calculation processing portion 8 to indicate the time has come for the capacity of the storage battery to be measured. Upon receiving the signal, the digital calculation processing portion 8 offers to the charger 2 an instruction to perform a charging and discharging pattern in a cycle of measuring the capacity of the storage battery, the pattern includes the following steps:

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charging, complete discharging to the termination voltage, and the calculation of function  $f(T_b)$  of the standard temperature  $Q_s$ . The value of the standard discharge capacity  $Q_s$  thus calculated is used as a standard discharge capacity for a predetermined number (for example 30 times) of charging and discharging cycles. Incidentally, compensation for the discharge capacity may be performed every time the battery is charged. But it is sufficient if such compensation is made at the predetermined charging times.

As discussed above, in the present invention, the standard charging capacity is compensated for depending on the number of charging and discharging cycles. Thus it is possible to accurately detect the remaining capacity even when the life of the battery is about to expire. It is also possible to accurately detect the actual capacity of the battery. Thus it is possible, when necessary, to display the change in the life of the battery in terms of the ratio of the capacity of the battery to the rated capacity. When the capacity of the battery has decreased to less than a level of

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the usage limit, a warning can be provided by means of a red lamp or the like.

In the above embodiment, the quantity of electricity detector 4, which generates an output signal proportional to the quantity of electricity, detects the quantity of the charged and discharged electricity. In another method, an amperage detector (for example small resistors inserted in series into a charged circuit through which charging and discharging current passes) may be used to detect the charging and discharging current, which enters into the digital calculation processing circuit 8, in which the charging and discharging current is time integrated. In this time integration process, the analog/digital converter 6 and the digital calculation processing portion 8 are intermittently operated by the timer 15. The current value measured in a certain time interval (for example 5 minutes) is used in the above time integration to detect the quantity of electricity over a period when the current value is not actually measured on the assumption that current flows uniformly even when such measurement is not carried out. When the variation in the load is small, the quantity of discharged

electricity can be calculated without fail even by such a method. Such a method even reduces the power consumed in the circuit of the remaining capacity meter.

In order to embody the construction illustrated in the block diagram shown in Figure 1, such devices, for example, as the portion 7 for detecting the quantity of charged and discharged electricity, the temperature detector 11, the digital calculation processing portion 8, the memory circuit 13, and the display unit 14 are incorporated into a unit to be attached to the storage battery 1 as accessories. When the storage battery 1 is connected to the charger 2, the charger 2 may be connected to the digital calculation processing portion 8 or the like so that a necessary signal is exchanged between them. In addition, when the load 3 (for example, a portable VTR and TV camera) can be provided with a terminal to which the charger is connected so that the storage battery 1 may be charged with the portion, mounted within the load 3 except the charging device 2 or when the charger 2 can be mounted within the load 3, all portions of the construction shown in Figure 1 can be incorporated into the load 3. With

respect to devices like the analog/digital converters 6 and 10 that can be either used inside or outside the load, the whole unit can be constructed so that the analog/digital converters 6 and 10 can be mounted either inside or outside the load 3.

In addition, each part of the construction shown in Figure 1 can be arranged separately such as, for example, a storage battery, a charger, and a load. Figure 5 is an embodiment in which each part is arranged separately. Referring to Figure 5, Symbols B, C, and L designate a unit arranged on the side of the storage battery 1, a unit arranged on the side of the charger, and a unit arranged on the side of the load, respectively. In other words, in this particular embodiment, a temperature detector 9 and a memory circuit 13 are mounted on the side of the storage battery 1 so that the detector 9 and the circuit 13 are integrated in the storage battery 1. On the side of the charger 2 are mounted a quantity of electricity detector 4C, an analog/digital converter 6L, a digital calculation processing portion 8, a display portion 14, and a dummy load 12, the quantity of electricity detector 4C detecting only the quantity of charged

electricity. On the side of the load 3 are mounted a quantity of electricity detector 4L, an analog/digital converter 6L, the digital calculation processing portion 8, the display portion 14 and a timer 15, the quantity of electricity detector 4C detecting only the quantity of discharged electricity. Here, the analog/digital converters 6C and 6L also serve as converters for converting an output signal from the temperature detector 9. Each analog/digital converter 6C and 6L alternately performs the digital conversion of a detected signal of the temperature and a digital conversion of the quantity of electricity. Since the charger 2 is connected to a commercial power source, no timer is mounted on the side of the charger. Since the memory circuit 13 is required to store common data between the calculation upon charging and the calculation upon discharging. In this particular embodiment, a timer 15 is mounted on one storage battery.

In accordance with the construction shown in Figure 5, when the battery is charged, terminals 16A, 17B, and 18B on unit B on the side of the storage battery each connecting to the storage battery 1, the temperature

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